MANUSCRIPT 5

DATA INTEGRATION AND SITE-SPECIFIC AMMONIA CRITERIA COMPLIANCE

CITY OF LINCOLN, NEBRASKA
SALT CREEK WATER QUALITY STUDIES

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DATA INTEGRATION AND SITE-SPECIFIC AMMONIA CRITERIA COMPLIANCE

Key Findings

The following are Key Findings which highlight the main points and conclusions of this manuscript. Extensive detail on the data integration and site-specific ammonia criteria compliance process and final recommendations and conclusions are also presented within this manuscript.

- A procedure using *in situ* study and bio-assessment results was developed to derive seasonal site-specific chronic total ammonia criteria that will be fully protective of the designated uses of Salt Creek Segment LP2-20000.

- *In situ* and bio-assessment study values for chronic total ammonia criteria were adjusted to account for summer and winter critical conditions with respect to pH and temperature following the EPA 1999 Ammonia Update and NDEQ guidance. Whole effluent toxicity testing results were also used to develop summer and winter chronic criteria.

- In developing site-specific chronic criteria for ammonia a weight-of-evidence approach is proposed that includes integrating extensive site-specific bio-assessment and *in situ* testing results in the context of the scientific recommendations of the water Environment Research Foundation Peer Review Panel.

- Proposed site-specific total ammonia chronic criteria are 2.1 mg N/L for summer and 5.4 mg N/L for winter based on an equal weighting approach between *in situ* and bio-assessment results.

- The City will comply with site-specific summer and winter chronic total ammonia criteria through a combination of end-of-pipe effluent limitations and Salt Creek in-stream compliance monitoring. This combined approach allows the City to use the assimilative capacity of Salt Creek and characterize Salt Creek on a daily basis. In the event of an end-of-pipe effluent limit exceedance, but with the Salt Creek in-stream total ammonia concentration below the criteria, no permit violation would occur.

1.0 INTRODUCTION

U.S. EPA's (1991) Technical Support Document for Water Quality-based Toxics Control states the following:

> *"Section 101(a) of the Clean Water Act states: "The objective of this Act is to restore and maintain the chemical, physical and biological integrity of the Nation's waters." Taken together, chemical, physical and biological integrity define the overall ecological integrity of an aquatic ecosystem. Regulatory agencies should strive to fully integrate all three approaches since each has its respective capabilities and limitations"* (p. 20).

The Nebraska Department of Environmental Quality (NDEQ) also states provisions in their *Title 117 – Nebraska Surface Water Quality Standards* that acceptable conditions occur for developing site-specific criteria. Under Title 117 Chapter 4 – *Standards for Water Quality*, sub-section 003.02A6b NDEQ allows for site-specific analysis for the modification of existing water quality criteria conducted in accordance with various procedures which are described in the *Water Quality Standards handbook, EPA December 1983.* One of the accepted procedures is listed under Title 117 sub-section 003.02A6B(4), which states the following:

> *"Other scientifically defensible procedures such as relevant aquatic field studies, laboratory tests, or available scientific literature".*

The City of Lincoln Salt Creek Water Quality Studies (SCWQS) follow this "other scientifically defensible procedures" approach and additional detail on data integration is provided within this manuscript.

The purpose of this manuscript is to describe the procedure for selecting site-specific chronic total ammonia water quality criteria that will be fully protective of the designated uses of Salt Creek Segment LP2-20000. In developing site-specific total ammonia criteria, the City of Lincoln (City) proposes a weight-of-evidence approach that includes integrating extensive site-specific bio-assessment and *in situ* testing results in the context of the scientific recommendations of the Water Environment Research Foundation (WERF) Peer Review Panel. Results from Whole Effluent Toxicity (WET) testing performed on both the Theresa Street and Northeast Wastewater Treatment Plants (WWTP's) are used as corroborative evidence in support of the integrated criteria. The chronic criteria are expressed as summer and winter values to address critical summer and winter conditions (seasonality) and its effect on ammonia toxicity.

Reasons for using both bio-assessment and *in situ* results in a weight-of-evidence approach lie in the particular strengths of each measure to assess aquatic life protection for ammonia. Bio-assessment provides a measurement of the potential impairment to the largest number of species in Salt Creek for the longest period of exposure. The data express the integration of impacts over time to the aquatic community. *In situ* tests specifically evaluate ammonia impacts to fish growth and survival as chronic sub-lethal

responses. This method is a real time measure of potential impacts. By considering the results together, protective total ammonia criteria can be developed for Salt Creek Segment LP2-20000.

Using the summer and winter site-specific chronic total ammonia criteria developed with this process, the City proposes a two-tiered approach to monitoring compliance with site-specific criteria. As discussed with the Nebraska Department of Environmental Quality (NDEQ) as a compliance option, Salt Creek in-stream monitoring, as well as end-of-pipe effluent limits, would be established to ensure compliance with site-specific criteria. Measurement Point 1 for compliance purposes would be the Salt Creek in-stream measurement and its comparison to the site-specific criteria. Measurement Point 2 for compliance purposes would be the end-of-pipe limit. This approach measures WWTP performance as well as actual ("real world") Salt Creek water quality conditions on (potentially) a daily basis. In the event of non-conformance with the total ammonia effluent limit by either WWTP, the "true" measure of chronic site-specific criteria compliance would be based on the Salt Creek in-stream concentration.

Additional description and basis for the selection and integration of data to develop seasonal site-specific chronic total ammonia criteria for Segment LP2-20000 of Salt Creek and compliance with the criteria are discussed in more detail below.

2.0 SUMMARY OF SALT CREEK STUDY RESULTS FOR AMMONIA CRITERIA

The City's SCWQS generated a tremendous volume of site-specific chemical, physical, and biological data that define the overall ecological integrity of the aquatic ecosystem, and are directly applicable to the development and support of site-specific water quality criteria for ammonia. Consistent with guidance in U.S. EPA's (1991) Technical Support Document, the key components are:

- The results from chronic *in situ* testing using fathead minnows and channel catfish.
- Six summer and five winter bio-assessment studies of the fish and benthic macroinvertebrate communities.
- Acute and chronic toxicity testing of effluents from the City's wastewater treatment plants.
- Chemical monitoring of effluent and Salt Creek.

Because of the relative scientific strengths of each of these technical components, a weight-of-evidence approach is a valid mechanism for integrating these data to yield a single aquatic life criterion that will be protective of Salt Creek. As discussed above, the weight-of-evidence concept was presented to the WERF Peer Review Panel, who fully agreed with the concept.

2.1 Presentation of Criteria.

The matrix shown in Table 5-1 presents the site-specific chronic total ammonia criteria in a manner that allows criteria to be evaluated independently, based on *in situ* study, bio-assessment, and WET results. This format is also a useful way to evaluate a weight-of-evidence approach for the purpose of determining seasonal site-specific water quality criteria. Table 5-1 shows Study Values generated from actual *in situ*, bio-assessment, and WET study results (second column), as well as study results adjusted for seasonal effects (critical summer and winter conditions) utilizing the EPA Ammonia Criteria Update (1999) and NDEQ *Procedures for Developing Point Source Total Maximum Daily Loads* guidance.

The criteria shown in Table 5-1 for the summer and winter seasons are adjusted Study Value results reflecting summer and winter critical pH and temperature conditions based on relationships in U.S. EPA's (1999) Ammonia Criteria Update (currently proposed for incorporation into NDEQ Title 117 – Nebraska Surface Water Quality Standards) and NDEQs required use of the median pH value and 75th percentile temperature value for each season.

The format for Table 5-1 shows: (1) the type of study, presented down the left side (ie., *in situ* results, bio-assessment results, and WET); and (2) the columns present the actual Study Values (and standard error, where appropriate) and the conversion of the study values into seasonal criteria values (summer and winter) based on the pH and temperature relationships presented in U.S. EPA's 1999 criteria document (see detailed Table 5-1 footnotes). To assist in following the logic from converting the Study Value to a summer or winter criterion, the following steps are provided which show, for example purposes, how the *in situ* channel catfish with the summer critical period defined as August (second row in Table 5-1) was completed.

- Channel catfish study value pH equals 7.7 s.u. and temperature equals 17 Deg. C, which equates to a 3.0 mg/L total ammonia criterion based on the EPA 1999 Update (see pg. 87 in 1999 update).

- Median Salt Creek pH for critical month of August (per NDEQ requirement) equals 8.1 s.u., which equates to a total ammonia criterion of 1.07 mg/L based on the EPA 1999 update (see pg. 87 in 1999 update).

- The reduction from 3.0 mg/L to 1.07 mg/L is 64 percent, or a 0.36 multiplier applied to the 3.9 mg/L Study Value.

- The resulting summer total ammonia criterion is 1.4 mg/L.

Table 5-1 Matrix of Site-Specific Ammonia Criteria Options Using EPA (1999) Ammonia Update for Seasonal Adjustment Factor

Criteria Source	Site-Specific Total Ammonia Chronic Criteria, mg N/L				
	Study Value	**Standard Error**	**Summer Season**	**Winter Season – Early Life Stage Present**	**Winter Season – Early Life Stage Absent**
In Situ					
In situ Channel Catfish w/ winter critical period defined as January	3.9	+/- 0.51	NA	NA	7.1[6]
In situ Channel Catfish w/ summer critical period defined as August	3.9	+/- 0.51	1.4[7]	NA	NA
In Situ – Fathead Minnow	>9.9[1]	NA	>3.6[7]	NA	>18.1[6]
In Situ – Fathead Minnow Adjusted for Sensitivity	>3.3[2]	NA	>1.2[7]	NA	>6.0[6]
Bio-assessment[3]					
Aquatic Community	2.1	NA	2.1[4]	NA	3.8[5]
Whole Effluent Toxicity[8]	6.7[9]		4.4[10]	13.2[10]	NA

[1]Based on highest exposure concentration (did not yield IC20 value). 30-day average value.
[2]Based on IC20 of >9.98/3.0 (from EPA 1999 criteria update; p. 70). Lab results may differ.
[3]Based on linear regression analysis with the threshold of impairment as Y = 0.15. Highest 30-day ammonia value, from simulation modeling, used to establish regression with metric relative difference.
[4]All collections were made during the summer season thus the study value equals the summer season.
[5]Winter – Winter value is based on multiplier as described in Footnote 6.
[6]Adjusted for winter condition assuming January is critical winter month. pH = 7.8 s.u. (median from City of Lincoln 1995 January HydroLab® data); Temperature = 3.8 Deg. C (75th percentile based on City of Lincoln 1995 January HydroLab® data). Multiplier = 1.81.
[7]Adjusted for summer condition assuming August is critical summer month. pH = 8.1 s.u. (median based on City of Lincoln 1995 August Hydrolab data); Temperature =25.5 Deg. C (75th percentile based on City of Lincoln 1995 August HydroLab® data). Multiplier = 0.36.
[8]Based on 7-day chronic WET testing for fathead minnows during *in situ* studies (9/26/99 – 10/10/99)
[9]Value is conservatively based on lowest IC_{20} value times lowest ammonia concentration from WET test samples.
[10]Seasonal values use EPA ammonia update (1999, p. 87) to convert WET test values (at pH/temp.) to NDEQ summer and winter pH/temperature values (8.1/27 and 7.9/7, respectively).

3.0 DISCUSSION OF AMMONIA CRITERIA WEIGHTING FACTORS

The City of Lincoln and their consulting team met with the WERF Peer Review Panel on June 3 – 4, 1999 to review the SCWQS. The objectives for the meeting included discussion of: additional analyses of the SCWQS data, study design details for *in situ* toxicity testing in Salt Creek that was scheduled for late summer 1999, and the derivation of a site-specific ammonia criterion for Segment LP2-20000. The City proposed to derive a site-specific criterion by integrating the results of the bio-assessments and *in situ* testing in a weight-of-evidence approach. The City and their consulting team discussed that approach again with the WERF Peer Review Panel during an April 6-7, 2000 meeting.

The City discussed the strengths and weaknesses of bio-assessments and *in situ* testing based on information provided in U.S. EPA's *Technical Support Document for Water Quality-based Controls* (1991) and by Mount (1994). The U.S. EPA and Mount documents did not compare *in situ* testing to bio-assessments *per se*. Rather, they discussed the value of WET testing, chemical-specific criteria, and bio-assessments for accurately measuring impacts and identifying the causes. On the basis of the conceptual strengths and weaknesses of the bio-assessments and *in situ* testing cited in these documents, the City proposed weighting the total ammonia concentrations derived from the two measurements equally, or possibility 0.66 for the bio-assessments and 0.33 for the *in situ* results.

The WERF Peer Review Panel responded that it was difficult to select the best method for integration *a priori*, because the integration should be empirical and based on the similarity of the results. The consensus of the WERF Peer Review Panel was that the integration should be based on the quality and quantity of the data, and the strength of the relationship between the biological response and total ammonia concentrations for the two measurements. The similarity of the protective total ammonia levels (between bio-assessment and *in situ* results) is important, because weighting concentrations that are widely different may result in splitting the difference between contradictory results. The end result of that process would be a site-specific criterion that was not biologically meaningful.

The quality and quantity of the results are discussed in the bio-assessment and *in situ* testing Manuscripts (Manuscripts 1 and 2, respectively). Briefly, total ammonia criteria derived with the bio-assessment data are based on the results of six annual summer sampling events. The total ammonia data used to calculate the effect levels for the biometrics are maximum 30-day average concentrations for 180-days prior to the sampling event. The biometrics (fish species, native cyprinid species, macroinvertebrate genera, and chironomid genera) selected to measure impacts in Salt Creek are reliable indicators of pollution stress. The metrics incorporate the response of a large number of taxa and the response of the dominant fish (cyprinids) and macroinvertebrate (chironomids) taxa in the stream. The pseudoreplicate sampling during the bio-assessments showed that data collected were representative of the conditions at the time of sampling.

The coefficient of determination (R^2) for the decline in fish taxa richness and total ammonia downstream from the Theresa St. WWTP was 0.86 (less Aug-98 data points) and for downstream of the Northeast WWTP it was 0.65. These correlations are significant since other effluents, non-point sources, and a host of other factors may have contributed to changes in taxa. Moreover, the coefficient of determination for declining fish taxa richness and total ammonia is corroborated by independent data. The data from Salt Creek shows that fish are more sensitive to ammonia than macroinvertebrates, and this difference in sensitivity is demonstrated in the national water quality criteria for ammonia (U.S. EPA. 1999). Also, the regressions for the fish metrics and ammonia demonstrate a long-term, chronic dose-response relationship for the fish community. The high correlations between the reductions in taxa richness for the 180-day exposure period to ammonia demonstrate the annual, repeatable change in fish community structure in response to elevated ammonia concentrations during spawning periods. The strength of these correlations is based on a consistent pattern in this response over a six-year period. The response of the fish to ammonia is similar for all fish species and native cyprinid species and for the ammonia discharges from both WWTP's. These corroborating data show that the bio-assessment data are an accurate measurement of ammonia impacts in Salt Creek.

Using the study design developed by the City's consulting team, and refined by discussions with the WERF Peer Review Panel, the *in situ* toxicity testing program involved continuous exposure of two resident species of fish for 30 days at nine stations in Salt Creek. Fathead minnows and channel catfish were selected because they are residents of Salt Creek; the catfish are defined as "key species" for segment LP2-20000; their relative sensitivity to ammonia; and the availability of applicable protocols. Replicate caged fish were placed at five specific locations below the Northeast WWTP to evaluate the effects of total ammonia, as well as four stations upstream of the facility to serve as experimental "controls." Replicate sizes and numbers were selected to allow the detection of a minimum 20 percent difference in growth between sites during a 30-day exposure with 90 percent confidence. The test design also included generation of an extensive site-specific chemical database for key water quality parameters during the 30-day program (e.g., total ammonia, pH, temperature, conductivity). The resulting 30-day IC20 value for the channel catfish was 3.9 mg N/L total ammonia, with a coefficient of variation (CV) of only 13 percent. By comparison, CVs for U.S. EPA's 7-day chronic effluent toxicity test protocols using fathead minnows and *Ceriodaphnia* are in the general range of 30 – 40 percent (U.S. EPA 1991). In addition, the channel catfish data showed a high degree of inverse association between total ammonia and decreased biomass ($r = -0.97$; $p<0.001$). In summary, the *in situ* study value for total ammonia of 3.9 mg N/L is a solid number that is supported by substantial site-specific toxicological and chemical databases and is reflective of the actual water quality conditions of Salt Creek during the 30-day exposure period (i.e., the in-stream variability of ammonia, pH, temperature, chloride, and other background water quality characteristics).

Finally, the protective levels of total ammonia estimated by the two methods are very similar. The level estimated by the fish biometrics is 2.1 mg N/L total ammonia for

summer. The EC20 calculated Study Value for the catfish is 3.9 mg N/L total ammonia. The similarity of these values demonstrates that the two measurements are giving similar information about the effect of ammonia in Salt Creek. The bio-assessments provide the most ecologically relevant information about ammonia toxicity, and the *in situ* tests provide the most precise information about the impacts of total ammonia on survival and growth.

It is recommended that 2.1 mg N/L total ammonia bio-assessment value be used in a weight-of-evidence approach with the EC20 Study Value of 3.9 mg N/L total ammonia derived from the *in situ* testing conducted in Salt Creek (see Manuscript 2) to derive the final site-specific criteria for total ammonia in Segment LP2-20000. Additionally, it is recommended that the ammonia criteria derived from bio-assessment be used as the lower bound or "floor" for the criteria calculation – meaning that the final criteria, for any season, should not be less than the 2.1 mg N/L value which has been shown to be protective to the indigenous community.

4.0 PROPOSED SITE-SPECIFIC CHRONIC AMMONIA CRITERIA

After ten years of intensive sampling and assessments of Salt Creek, scientific review by the WERF Peer Review Panel, and discussions with and guidance from NDEQ, the City has developed final recommendations for a total ammonia criterion for Salt Creek. These recommendations are based on a sound, scientific approach and site-specific biological and chemical data from Salt Creek.

The City proposes that the results of the *in situ* tests and the bio-assessments be weighted equally in deriving the site-specific ammonia criteria for Salt Creek. An average of the two values is recommended.

Criterion = (bio-assessment value + *in situ* value)/2

As discussed in subsections above and shown in Table 5-1, the current criteria correction for winter and summer would be based on the 1999 Ammonia Criteria document (EPA 1999), as proposed for NDEQ Title 117 – Nebraska Surface Water Quality Standards. It is also proposed that the ammonia criteria derived from bio-assessment be used as the lower bound or "floor" for the criteria calculation – meaning that the final Salt Creek site-specific criteria should not be less than the 2.1 mg N/L value which has been shown to be protective to the indigenous community. The resulting proposed values based on the current Title 117 language and the 1999 Ammonia Criteria Update, and use of the lower bound or "floor" value, are presented in Table 5-2, below.

Table 5-2 Proposed Chronic Site-Specific Total Ammonia Criteria (mg N/L) Based on Equal Weighting		
	Summer	**Winter**
Criteria Based on EPA Ammonia Criteria Document 1999 Update		
Bio-assessment Value	2.1	3.8
In situ Value	1.4	7.1
Proposed Criteria	**2.1**[1]	**5.4**

[1]Lower bound or "floor" value based on criteria derived from bio-assessment.

A discussion of compliance with these proposed site-specific chronic criteria is presented in the following section.

5.0 PROPOSED NPDES PERMIT COMPLIANCE PROVISIONS

5.1 Dual Application of In-Stream Criteria and End-of-Pipe Effluent Limits

The City will comply with the site-specific in-stream summer and winter chronic ammonia criteria, as defined above, through a combination of end-of-pipe effluent limitations and Salt Creek in-stream compliance monitoring. Currently, NDEQ defines the summer period as April through October and winter as November through March. NDEQ has recently proposed modifications to the seasons by moving the month of March into the summer period. The two-tiered approach allows the City to monitor WWTP performance at the point of discharge but also allows the City to characterize Salt Creek Segment LP2-20000 for total ammonia on potentially a daily basis. Measurement Point 1 for compliance purposes would be the Salt Creek in-stream measurement and its comparison to the site-specific criteria. Measurement Point 2 would be the end-of-pipe limit. Following this compliance approach, the City would not be in violation of their National Pollutant Discharge Elimination System (NPDES) permit total ammonia limitations if the effluent limit is exceeded, but the corresponding Salt Creek in-stream concentration, at the point of compliance, does not exceed the chronic criterion. Both the effluent limit and in-stream concentration would be based on 30-day average concentrations. Exceedance of both the 30-day average effluent limit and the in-stream chronic criteria, based on a 30-day average in-stream concentration, would potentially constitute an NPDES permit violation.

By focusing compliance on in-stream ammonia concentrations versus end-of-pipe effluent limits, the assimilative capacity of Salt Creek can be more fully utilized on a daily basis. The primary factor affecting the assimilative capacity of Salt Creek for ammonia is the quantity of flow available for dilution. Secondary factors include the natural ammonia decay and uptake mechanics in Salt Creek which play an important, but difficult to define role in determining actual in-stream ammonia concentrations. The concept of in-stream ammonia compliance is preferred as opposed to fixed effluent limit based on a statistically derived 7Q10 chronic low-flow, which is proposed by NDEQ to be changed to the 30Q5 low flow. Theoretically, the instream low-flow occurs

infrequently and is of questionable accuracy due to the limitations of low-flow measurement capability at USGS gauging stations, as identified at the Salt Creek 27th Street gauge. The issue of the 27th Street gauge inaccuracy has been extensively addressed by the City and NDEQ and a proposed resolution is as follows: (1) flow measurements of 107 cfs or less (approximate 3-foot gage height or less) are inaccurate, and flows are actually higher than the measured flow; (2) address the median error (gauge reads low) of 39.8 percent at flows of 107 cfs and less with the application of an adjustment factor; and (3) adjust the 30Q5 summer flow to 56.1 cfs and the winter 30Q5 low-flow to 64.1 cfs.

The more traditional approach of limiting effluent discharges to a single seasonal value based on extreme low-flow conditions is considered to be overly conservative most of the time. This approach does not allow for the practical use of excess assimilative capacity available at higher flows, which occur a high percentage of the time in Salt Creek. Additionally, Salt Creek in-stream ammonia compliance is supported through the collection of site-specific Salt Creek data over the course of ten years under the Salt Creek Water Quality Studies, including extensive chemical analysis, biological assessments, *in situ* studies, and development of site-specific chronic criteria.

Focusing site-specific chronic ammonia criteria compliance on actual Salt Creek conditions allows the City to assess "real world" conditions in Salt Creek and not be restricted to conditions that may not realistically occur in Salt Creek. The following benefits would also be provided.

- Assessment of actual long-term (chronic) conditions.
- Maximum Salt Creek watershed protection and continued comprehensive Salt Creek mainstem characterization for NDEQ and other agency benefit.
- Measures actual in-stream conditions and utilizes allowable assimilative capacity on a daily basis as a way to assess "true" aquatic life protection.
- Places the burden on the City of Lincoln to complete extensive daily monitoring and be accountable for in-stream conditions excluding upstream non-point source impacts.

This approach to NPDES permit compliance is very similar to that utilized by the South Dakota Department of Environment and Natural Resources for several municipal and industrial dischargers. These dischargers in State of South Dakota include: Rapid City, City of Mitchell, Bald Mountain-Lead Mining District and the Richmond Hill mine.

5.2 Proposed Basis for End-of-Pipe Effluent Limit Calculations

For compliance purposes, the City's Theresa Street and Northeast WWTP's would have end-of-pipe chronic total ammonia effluent limits in conjunction with in-stream Salt Creek monitoring for compliance. The City also proposes that such effluent limits be

based on wasteload allocation (WLA) calculations and not include the second step of converting the WLA into permit limits, as applied by NDEQ and defined in their *NPDES Permitting Procedure, 1995,* document. This approach is more appropriate for site-specific applications like this, rather than including the additional step of converting the WLA into a permit limit and applying unnecessary "safety factors" that have been inherently accounted for in the development of the site-specific chronic total ammonia criteria for Salt Creek Segment LP2-20000. Following this approach, the WLA-based chronic effluent total ammonia limits would primarily be a function of the following factors.

- Site-specific summer and winter chronic total ammonia criteria for Salt Creek Segment LP2-20000 as defined through the Salt Creek Water Quality Studies.
- Salt Creek 30Q5 low-flow for summer and winter.
- Theresa Street and Northeast WWTP year 2006 design flows.
- Seasonal (summer and winter) background total ammonia concentrations based on historic data.
- Seasonal ammonia decay between the end of the Theresa Street chronic mixing zone and the Northeast WWTP.

Ammonia effluent monitoring results would be submitted with the City's monthly discharge monitoring reports.

5.3 Proposed End-of-Pipe Effluent Limits

Provided below in Table 5-3 are chronic total ammonia effluent limits based on a WLA calculation and the proposed site-specific chronic criteria as documented in Table 5-2 using an equal weighting (50/50 split) of the criteria based on bio-assessment and *in situ* study values. These criteria were used to calculate proposed end-of-pipe permit limits following NDEQs standard WLA procedure, and do not include NDEQ's second step, which converts the WLA into permit limits, which applies multiple safety factors. The approach of using the WLA values as permit limits is more appropriate for site-specific applications and does not warrant the application of unnecessary safety factors. To evaluate a potential worst-case scenario, permit limits were also calculated based on using the *in situ* Study Value and bio-assessment Study Value, only, since the *in situ* value alone is more restrictive during the summer season than the combined bio-assessment and *in situ* testing study values and the "floor" bio-assessment value. Proposed end-of-pipe ammonia limits are shown in Table 5-3.

The chronic ammonia effluent limits presented in Table 5-3 are based site-specific criteria as presented in Table 5-1, which are based on the EPA 1999 Ammonia Criteria Update used in the summer and winter season conversion process from the Study Value (see Table 5-2). Although site-specific chronic criteria compliance would ultimately be

based on in-stream compliance monitoring, versus end-of-pipe permit limits, the permit limits shown in Table 5-3 are still useful, primarily for assessing the ability of each WWTP to meet the potential limits after completion of ongoing WWTP modifications.

Table 5-3 Comparison of Potential Chronic Ammonia Effluent Values Based on Various Site-Specific Ammonia Criteria

Scenario	Total Ammonia In-Stream Criteria, mg N/L	Corrected 30Q5 Low-Flow, cfs (Upstream of Theresa St. WWTP)	Theresa Street WWTP Total Ammonia End-of-Pipe Permit Limit, mg N/L (Based on WLA)	Northeast WWTP Total Ammonia End-of-Pipe Permit Limit, mg N/L (Based on WLA)
Summer Season				
Site-Specific: Criteria Based **on Equal Weighting of Bio-assessment and i*n Situ* Study Values and 30Q5 Low-Flow**	2.1	56.1	5.5	17.6
Site-Specific: Criteria Based on **i*n Situ* Study Value Only and 30Q5 Low-Flow**	1.4	56.1	3.5	11.6
Site-Specific: Criteria Based on **Bio-assessment Study Value Only and 30Q5 Low-Flow**	2.1	56.1	5.5	17.6
Winter Season				
Site-Specific: Criteria Based on **Equal Weighting of Bio-assessment and i*n Situ* Study Values and 30Q5 Low-Flow**	5.4	64.1	15.2	23.9
Site-Specific: Criteria Based on **i*n Situ* Study Value Only and 30Q5 Low-Flow**	7.1	64.1	21.4	31.5
Site-Specific: Criteria Based on **Bio-Assessment Study Value Only and 30Q5 Low-Flow**	3.8	64.1	10.3	16.8

5.4 Compliance Monitoring Locations for Ammonia

5.4.1 In-Stream Considerations

Salt Creek in-stream compliance monitoring will require the City to conduct daily total ammonia (as nitrogen), flow, and possibly other field measurement monitoring to evaluate compliance in Salt Creek. The frequency of in-stream monitoring could potentially be reduced when Salt Creek flows are above a high flow cutoff point. This could be defined through simple mass balance to determine the point where neither WWTP, based on their effluent flow rate and concentration, would exceed the site-specific ammonia criteria in Salt Creek. The chronic points of compliance in Salt Creek are the ends of the Theresa Street and Northeast WWTP regulatory chronic mixing zones as defined by NDEQ (maximum of 5,000 feet below each point of discharge).

5.4.2 Proposed Monitoring Locations and Frequencies

Salt Creek monitoring for in-stream compliance will be conducted at a frequency sufficient to meet regulatory needs and results submitted with the City's monthly discharge monitoring reports. The proposed monitoring locations and frequencies are shown in Table 5-4.

Table 5-4 Proposed Monitoring Locations and Frequencies for In-stream Compliance Monitoring

Monitoring Location	Monitoring Frequency	
	Daily or Less[1]	Daily
Directly Upstream of Theresa St. WWTP	X	
Theresa St. WWTP Effluent		X
End of Theresa St. WWTP Chronic Mixing Zone (point of compliance for Theresa St. WWTP)	X	
Directly Above Northeast WWTP	X	
Northeast WWTP Effluent		X
End of Northeast WWTP Chronic Mixing Zone (point of compliance for Northeast WWTP)	X	

[1]Frequency will be based on Salt Creek flow rate.

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Links to Supporting Data Files